NOTES ON THE HABITS OF CERTAIN AUSTRALIAN THYNNIDÆ

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ABSTRACT

This paper gives observations made on the flight, mating and feeding habits of certain Australian Thynnidæ, and discusses these habits in relation to a few typical habitats. Brief descriptions are given of the egg, larva and larval feeding habits.

During the period from 1930 to 1932, the writer was stationed in Australia, and engaged in research on the parasites of the Scarabæidæ for two seasons of field work, during the course of which two species of Ortalidæ and four or five species of Tachinidæ were found as parasites of adult beetles. The larval parasites encountered were one species of Tachinidæ and members of the families Scoliidæ and Thynnidæ. The Thynnidæ are a most interesting group because of their very peculiar habits about which little has been published. (Plate IV).[1]

The digger wasps of the family Thynnidæ are now placed in the superfamily Mutilloidea. The observations treated in this paper were made on members of the subfamily Rhagigasterinæ and Thynninæ, which occur chiefly in Australia. They are represented by many genera and over 400 described species. Some earlier writers suggested that thynnids, like the mutillids, were parasites of other aculeate Hymenoptera, but Froggatt (1),[2] Bridwell (3), and Tillyard (4) consider that they parasitize soil inhabiting Coleoptera of the family Scarabæidæ. To the writer's knowledge, however, there are no host records in the literature and only one instance on record of an egg being deposited on a scarabæid larva by a thynid (5). During the studies recorded

[1] This illustration was very kindly prepared by Mr. R. J. Sim of the Moorestown laboratory of the Bureau of Entomology.

[2] Figures in parenthesis refer to Literature Cited.

in this paper approximately 24 species representing some sixteen genera were observed, and many of them tested in the laboratory with scarabæid larvæ. The species on which fairly complete observations on some phase of their habits were made are listed herewith.[3]

Subfamily	*Genus and Species*
Rhagigasterinae	*Dimorphothynnus morio* Westw.
"	*Eirone ichneumoniformis* Smith
"	*Rhagigaster aculeatus* Sauss.
"	*Rhagigaster unicolor* Guer.
"	*Rhagigaster unicolor* var. *mandibularis* Westw.
Thynninae	*Epactiothynnus pavidus* Smith
"	*Glaphyrothynnus zanthorrhoei* Smith
"	*Hemithynnus apterus* Oliv.
"	*Lophocheilus obscurus* Klug.
"	*Neozeleboria proximus* Turner
"	*Thynnoides fulvipes* Guer.
"	*Thynnoides fumipennis* Westw.
"	*Thynnoides sensilis* Erich.
"	*Tmesothynnus zelebori* Sauss.
"	*Zaspilothynnus leachiellus* Westw.
"	*Zeleboria monticollis* Turner
"	*Zeleboria nitidulus* Turner
"	*Zeleboria sexmaculata* Smith
"	*Zeleboria trivialis* Smith

These observations were made in three different types of habitats. The first of these was the coastal plain type. This habitat is usually close to the actual coast line. Generally it has a very light sandy soil, and the ground cover is bunch grass. There is an abundance of large and small flowering shrubbery, at least some of which is in blossom during the greater part of the season. The most common of these are the species of the "tea-tree" (*Leptospermum* spp. and *Melaleuca* spp.). Large trees are relatively few. These areas have an abundance of rainfall. A second type of habitat is the tableland sections of New South Wales. These are extensive plateaus paralleling the coast and varying in altitude from approximately 1,000 to 3,000 feet.

[3] These determinations were made by Mr. K. E. W. Salter, who at the time was a graduate student at Sydney University, and was specializing in the Thynnidæ.

They have about half the amount of rainfall that the coastal sections receive, and are devoted chiefly to grazing. The soil is usually hard and packed and the ground cover is grass. There are scattered wooded tracts which have not as yet been cleared to enlarge grazing areas. Most of the blossoms in this habitat are the flowers of the various species of *Eucalyptus* trees. A third type of habitat is the farming country, areas of rich soil and abundant rainfall. The farming practiced is chiefly truck gardening, deciduous fruit raising, and dairying. The ground cover of the uncultivated land is varied and commonly consists of either wooded areas or of extensive pastures. Some species of flowering shrubs are fairly common. General observations on Thynnidæ were made in representative areas of these three types of habitats. Most of the detailed observations were made in the farming country habitat.

In the coastal plain type, thynnids may be taken in small numbers at almost any time from early spring to late autumn, with the exception of the driest part of the summer. During collecting trips a number of species were usually taken, but *Rhagigaster aculeatus* Sauss. was the only one found in great numerical abundance. The majority of the species found in these areas were blossom feeders, a few examples being *Dimorphothynnus morio, Rhagigaster aculeatus, R. unicolor, Hemithynnus apterus,* and *Lophocheilus obscurus.*

In the tablelands habitat, somewhat similar to the coastal strip, there is a fair abundance of species without any great numerical abundance, although the species are not as numerous here as in the coastal habitat. In the tablelands a majority of the thynnids were found feeding on the blossoms of *Eucalyptus,* but many were also seen feeding on exudations from scale insects which were more noticeably abundant in this habitat than in the coastal areas.

Rhagigaster unicolor variety *mandibularis* and *Zeleboria trivialis* were found as scale feeders in this area while *Aeolothynnus umbripennis* Smith and *Agriomyia luctuosus* Smith were taken on blossoms. The farming country habitat differs from either of the others. The number of species found here seems to be less than in the other areas. Fewer species were found in any

given area which could be covered in any one day of collecting. However, the numerical abundance of individuals of most of the species found in the farming country was markedly greater than in either of the other habitats and several hundred individuals per day could be collected with ease at the concentration points. Nearly all of the species found so abundant in these areas feed on the exudations of scale insects, especially in the dairy country where relatively few blossom feeders were found.

Some of the more numerous species found feeding on scale exudations in this habitat were *Thynnoides fulvipes, T. senilis, Zeleboria nitidulus, Z. sexmaculata, Eirone ichneumoniformis* and *Neozeleboria proximus.*

A few species, such as *Hemithynnus apterus, Rhagigaster unicolor,* and others not identified, were found in all these habitats, but not in abundance.

All of the female Thynnidæ are wingless. The males are winged and are much larger than the females, ranging in size from 6 mm. to 35 mm., and are very strong fliers. On sunny days they begin flight about 8 in the morning and from then until midday their flying is fairly close to the ground and seems concentrated on finding the females. The females first appear in the morning about half past 8 or 9. On cultivated areas males of *Thynnoides fulvipes* were observed on several occasions digging at small cracks in the ground. Sometimes they would be so engaged for several minutes before the female emerged from the crack and coupling occurred. In the tall grass and shrub regions the males usually do not locate the females until the latter are well out of the ground. Females of *Zeleboria nitidulus* and *Z. sexmaculata* were watched emerging from this type of habitat and their usual procedure on leaving the ground was to climb the nearest twig or grass blade. After climbing a foot or so they would turn around, face the ground, and move their abdomen back and forth a few times. A male would soon swoop down and couple with the female, sometimes without alighting, and then fly off to the feeding grounds with the female hanging from the end of his abdomen. In observations made on those species feeding on flowers such as *Dimorphothynnus morio* and *Rhagigaster aculeatus*, the male usually alighted on

the edge of the petals and then turned facing away from the center of the flower. The female crawled into the center of the flower without disengaging and fed on the nectar. After half a minute or so the male would fly off to another flower and the procedure would be repeated. During this process the males make no attempt to feed. The habits are somewhat similar when the thynnids are feeding on scale insect exudations. The males of *Neozeleboria proximus*, *Zeleboria nitidulus* and *Z. sexmaculata* fly onto the scale-infested leaves and crawl slowly about on them, allowing the females to feed. Often when a particularly good feeding spot is encountered the female tries to remain there longer, but she is seldom able to get a good foothold and is dragged off by the male. Coupling is a daily event in favorable weather.

There are three functions served by this coupling of the thynnids. The first is transportation of the females to the feeding places and subsequent feeding, which has already been described. The second function is mating. The third function is the transportation and dissemination of the species.

It is logical to assume that mating takes place at least once during the time the female is being carried about by a male of the same species. The writer is of the opinion, however, that mating occurs more than once, and perhaps each time a pair are coupled, though Turner (2) notes that males have been taken paired with females of another species. Females spend most of their time in the ground. They are only rarely observed walking about on the ground. The males, so far as observed, do not reenter the ground once they have emerged from the cocoon. Thus it seems that the time spent by the pairs flying about is the only time that the males have access to the females.

As stated, the third function of the coupling process is the dissemination of the species, which has been noted by Turner (2) and according to this observer it may be carried to such a point that females of several species may occasionally be transported by males of other species. Females are wingless and their legs are adapted for burrowing and not for extensive walking. The usual habit of the females is to disengage from the males, drop to the ground, and proceed to burrow in. A few cases were

observed where the female dropped off while the male was in full flight and more than 10 feet in the air, but it is not known whether or not this is the usual practice. Little is known about the efficiency of such a method of dissemination; however, in spite of the typically spotty distribution of host grubs in nature, the method certainly seems to be successful as evidenced by the abundance of individuals of some species.

On sunny days males begin flying about 8 o'clock in the morning and spend most of the morning flying close to the ground seeking the females. They were never seen to hover about one spot in numbers, as is frequent with some species of *Tiphia,* but generally fly about alone. They were seen at this time of day in all manner of places and in bushy and wooded country as well as in the open pastures and over cultivated ground. During the afternoon their flight is higher, and it is at this time of day that they are most frequently seen feeding. About 4 or 5 in the afternoon their flights become less frequent and they soon alight on tall grass blades or small twigs of bushy shrubs, fold their wings and remain motionless for the night. Most of them seem to choose a place within 4 feet above the ground, though where a species is abundant some rest at higher levels. From laboratory rearings it seems that the males emerge a few days ahead of the females. The males persist in abundance throughout the entire period of adult activity. This is in direct contrast to male *Tiphia,* which have a peak of abundance that is reached several days before the peak of the females. In *Tiphia* the males soon die off after reaching this peak, and during the latter part of the season they are scarce while the females are still abundant. It is assumed that the extent of the male life in the Thynnidæ is due to the fact that they also have the function of transportation to fulfill. It was thought at first that the continued abundance of males might be due to a condition where males normally outnumber the females in abundance and are present at all times by virtue of part of them being delayed in emergence, but several large lots of field dug cocoons were held for emergence in the laboratory and the sex ratio of males and females in the emergence was approximately equal.

When the females detach from the males they immediately dig

into the ground and begin their search for a suitable host. On finding a host they attack and sting it. The sting causes permanent paralysis; it is often severe and occasionally kills the host. The paralyzed hosts are left in their feeding cell and are not moved by the thynnid. Under laboratory conditions females frequently sting several grubs a day without apparent regard for the species of grub, but deposit no eggs. Representatives of five different genera, *Thynnoides fulvipes, Tmesothynnus zelebori, Zaspilothynnus leachiellus, Neozeleboria proximus* and *Glaphyrothynnus zanthorrhoei* deposited eggs in the laboratory. The grubs used as hosts by *Glaphyrothynnus* and *Zaspilothynnus* were not identified, and only two eggs were obtained from each. *Thynnoides* laid on several hosts, but the grubs of *Scitala* sp. were apparently preferred. All except one or two of the eggs of *Zeozeleboria* were placed on grubs identified as *Heteronyx aphodioides* Blch.

Only two of these, *Tmesothynnus zelebori* Sauss. and *Neozeleboria proximus* Turner, were reared as far as the cocoon stage. The cocoons of *Neozeleboria* had to be abandoned because of the termination of the Australian project. An adult of *Tmesothynnus zelebori* Sauss. was reared from an egg deposited in the laboratory on a grub of *Phyllotocus* sp.

After stinging the grub the next step is egg deposition. In all the instances of egg deposition under laboratory conditions by the various species of Thynnidæ the egg was deposited on the ventral surface of the host, on or near the median line of the second, third or fourth abdominal segment. The egg is very loosely attached to the host and is frequently brushed off despite care in handling. The females do not malaxate or prepare any particular point on the host grub before depositing their egg as do female *Tiphia.* There is apparently no adhesive substance used to attach the egg to the host. The egg itself is slightly sticky and will adhere to a brush or the tip of a forceps as readily as to the host grub. The egg is elliptical in shape and most of those secured were fairly uniform in size, measuring about 3 mm. by 0.8 mm. When first laid the egg is pure white, but it soon obtains a faint yellowish tinge. The chorion is faintly reticulated, is very flexible, and readily depresses when a forceps

or blunt needle point is rested against it. The approximate incubation period is two or three days. Eggs can be transferred from one paralyzed host to another without injury and when they are so transferred they hatch normally; the larvæ begin feeding, and seem normal in every respect.

The young thynnid larva is very active upon hatching and is frequently found attached to its host at a spot several segments away from the place where the egg was deposited. All feeding larvæ lie along the long axis of the host, their heads directed toward the cephalic end of the host. When larvæ move away from the segment where the egg was laid and begin feeding at some other point the place selected is near the median ventral line. No cases of dorsal oviposition or feeding were observed in the species worked with. The young thynnid larva is possessed of strong prominent mandibles, but after the feeding puncture is torn in the host derm the feeding seems to be by suctorial action, at least for the first few days. The larva is not a "clean" feeder as are the larvæ of *Tiphia*. After the young thynnid larva has hatched and is ready to begin feeding it tears an irregular hole in the host derm with its mandibles. This hole is invariably much larger than the head of the larva can fill and consequently the host fluids exude from around the feeding puncture and bathe the head of the feeding larva, and frequently its entire ventral surface. This feeding habit is apparently responsible for the bacterial infection of the host which often set in and caused the host to turn black in less than a day and subsequently killed the parasite. This tendency to infection was the main cause of the death of many of the larvæ that were kept in the laboratory and the few that were successfully reared through to the cocoon stage were kept in small tubes between plugs of moist cotton. In the specimens reared in the laboratory the extremes of the larval feeding period were 5 and 13 days. This was apparently governed somewhat by the amount of food available. The thynnid larva is of the usual elliptical shape characteristic of the Scoliidæ and Tiphiidæ and it is faintly yellowish in color. The head is well demarked from the rest of the body by a fairly strong constriction. The segmentation of the abdomen is very faint. Thynnid larvæ could easily be dis-

tinguished from any of the scoliid larvæ that were encountered in Australia. A number of scoliid larvæ were taken in the field and reared and, without exception, they had each segment of the abdomen marked by a constriction, as well as the separation between the head and the rest of the body.

After the completion of feeding the larvæ spin their cocoons within the cell of the host. The cocoons are of the usual elliptical shape common to cocoons of Scoliidæ and Tiphiidæ. They are made up of numerous closely appressed layers of silk. There is also some loosely woven silk partially filling the host cell. Cocoons were found in the field at depths varying from 1 to 8 inches. Thynnid cocoons could be readily distinguished from scoliid cocoons because all of the latter observed in Australia had a double cocoon which consisted of the usual strong inner cocoon and outside of that another flexible outer envelope.

While no special studies were made to determine the economic value of Thynnidæ in the Australian fauna, that this group is of some value is clear from the fact that some of the species tested by the writer were found to be definitely parasitic on scarabæid larvæ. In addition to the evidence already presented, abundant proof of the nature of their parasitism was found in the field. During the course of these observations many thynnid cocoons were dug in the field. Some of them were dug so that only a part of the host cell was broken away exposing the cocoon, and in most of the cells so found there was the head capsule of the host entangled in the outer layers of the cocoon. These were saved and examined under the microscope and found to be scarabæid head capsules. Evidence of the number of scarabæids destroyed by thynnids was obtained from some of the diggings in addition to the evidence presented by the abundance of thynnids in the field as adults. In some diggings in restricted areas, cocoons of the same species were found as many as ten to the square foot, averaged over a number of diggings.

From these observations it seems that the Thynnidæ would be of use if they could find suitable host material when introduced into new habitats, and provided that they were free of retarding factors such as secondary parasitism. During these studies thynnids were found to be parasitized by bombyliids and mutil-

lids. Several bombyliids were reared, but the most abundant parasites were the mutillids. In three fairly large collections of thynnid cocoons from the field the mutillid parasitization ranged from 8 to 20 percent.

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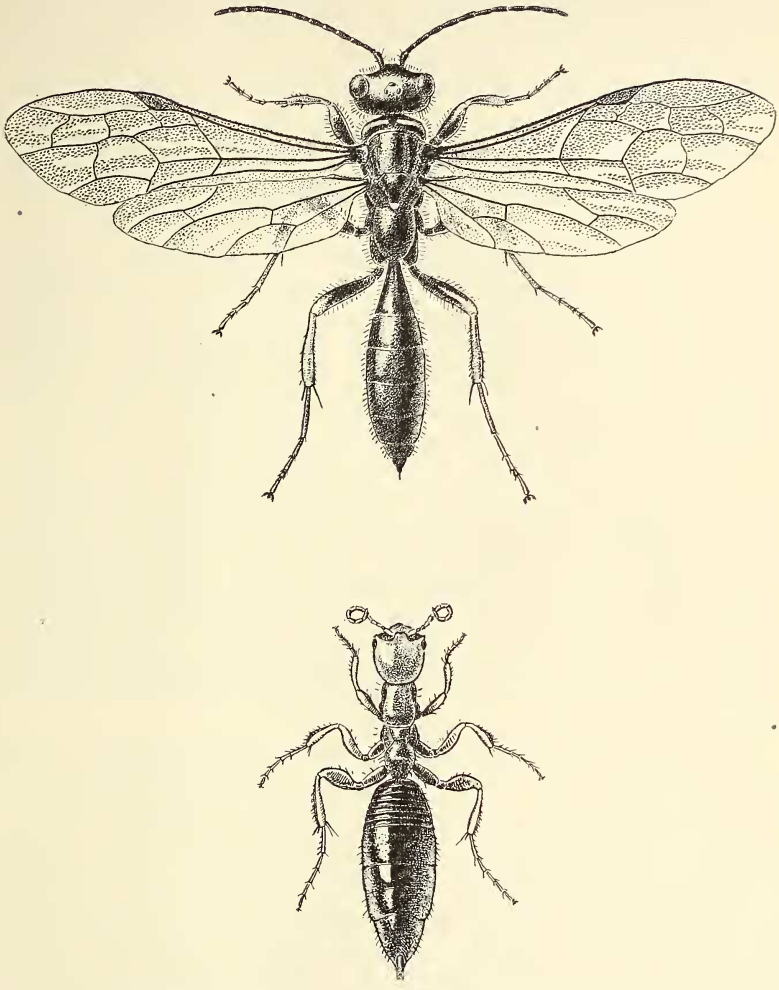

ADULTS OF *NEOZELEBORIA PROXIMUS* TURNER